Space Telescope Pointing Control

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The Space Telescope pointing control system is designed to meet the fine pointing performance of 0.007 arc-sec stability, maneuver the telescope 90 deg in 18 min, or less, and provide the capability for deployment from, and retrieval by, the space shuttle. The pointing control system objectives are met using fine guidance sensors for attitude information, reaction wheel assemblies sized to provide both the torque required for maneuvering and the precision control torques during fine pointing, and magnetometers and magnetic torquers for momentum management. A digital computer is used to calculate the control law, attitude reference, momentum management law, and command generator. The command generator shapes the acceleration and incremental angle commands to the control system to limit structural mode excitation.

The input to the control system (see FIGURE 1) is the command generator acceleration and incremental position commands, rate gyro assembly "incremental" angles per 25 ms and the fine guidance sensor angle output for attitude. The rate gyro assembly data can be used for both rate and short-term attitude. The control system uses position, rate, and integral compensation. A digital filter is used in the rate path to suppress Space Telescope structural modes. The optical telescope assembly modal parameter values are large and require suppression to maintain adequate stability margins.

The acceleration command effectively goes directly to the reaction wheel torquers and puts an instantaneous torque on the vehicle. The reaction wheel torque response is governed only by the feed forward path, which has a bandwidth of approximately 80 Hz. Therefore, the vehicle follows the shaped acceleration commands. The feedback provides an error correction path to account for variances in parameters such as the vehicle inertia estimate and the reaction wheel feed forward gain. A closed loop on the reaction wheel provides compensation to overcome the bearing drag torque and has a bandwidth of approximately 0.1 rads/s.

The control loop is a high gain system and all input to the control system must be smoothed by the command generator to prevent loop saturation and the resulting vehicle instability from initiating backup mode entry. Disturbance torques, e.g., gravity gradient and aerodynamics, act upon the Space Telescope causing the wheel speeds of the reaction wheel assemblies to increase. To prevent the reaction wheels from reaching a saturated condition that would cause a loss of vehicle control, a momentum control system that manages the speed buildup in the reaction wheels is provided. Momentum control operates concurrently with the primary loop. This system uses a magnetometer or an onboard computer model of the Earth's magnetic field, and magnetic torquers for control torques.

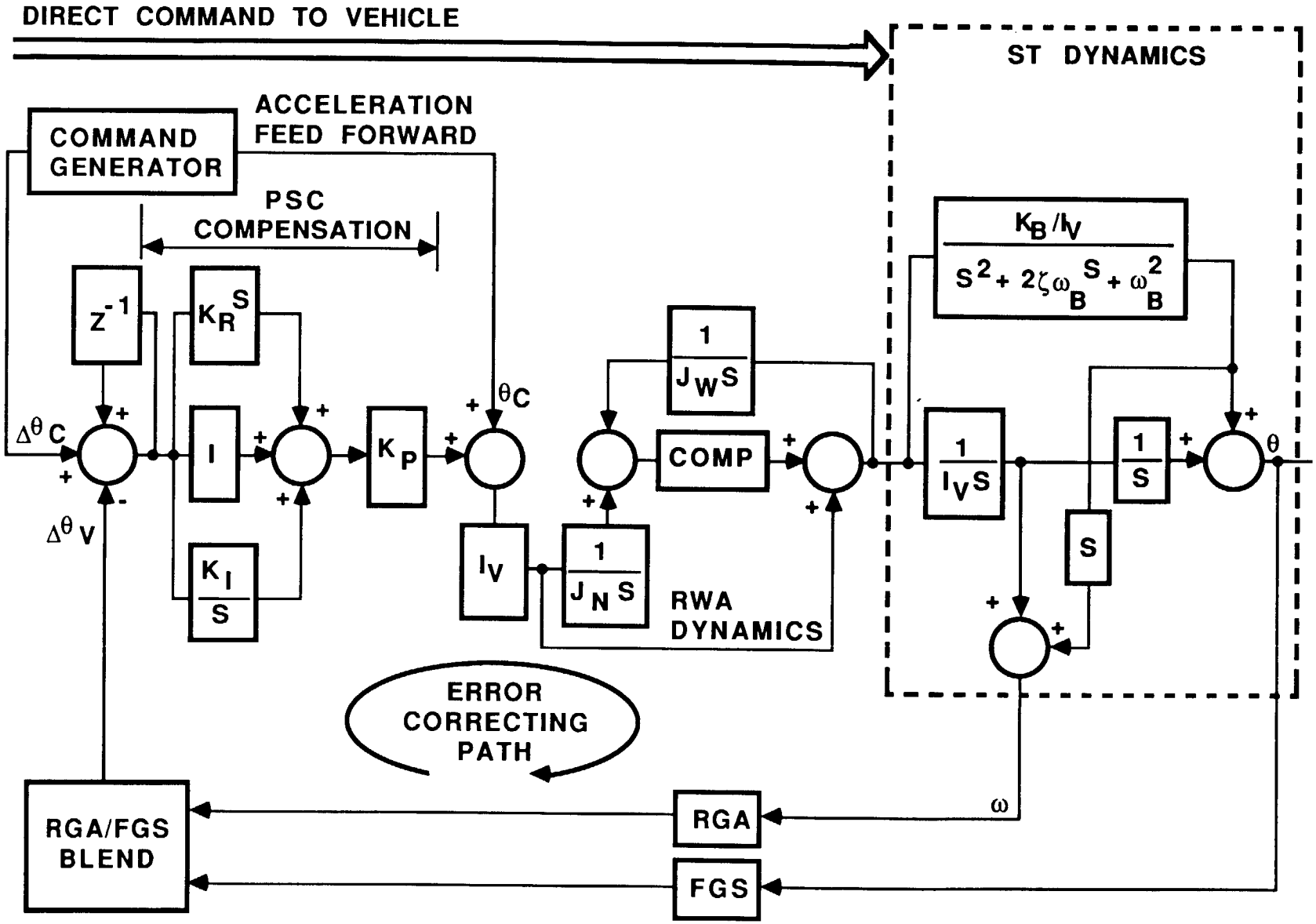

FIGURE 1. Schematic Diagram of the Space Telescope Fine Pointing Mode